PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H03H 11/04, H04M 11/06, H04L 5/06

A1

(11) International Publication Number: **WO 99/39433**

(43) International Publication Date: 5 August 1999 (05.08.99)

(21) International Application Number: PCT/SE99/00036

(22) International Filing Date: 14 January 1999 (14.01.99)

(30) Priority Data:
9800240-5 29 January 1998 (29.01.98) SE

(71) Applicant *(for all designated States except US)*: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

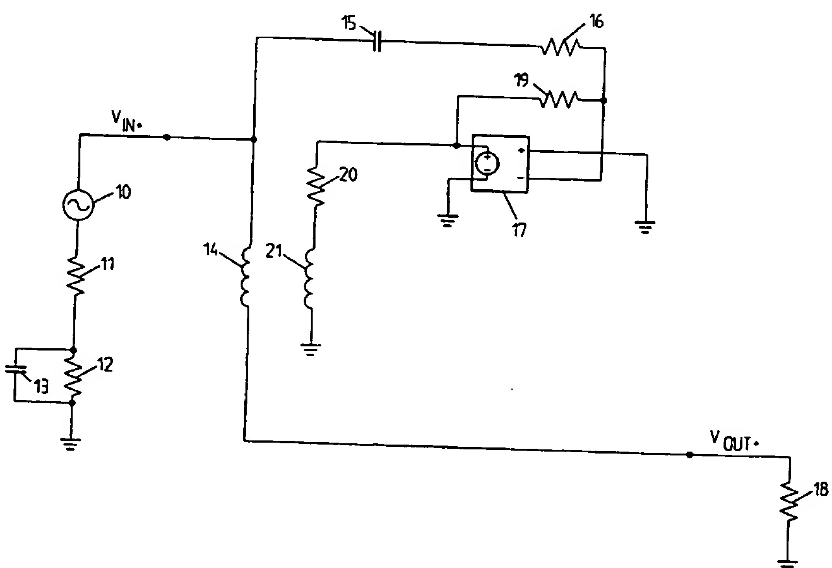
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: BLADH, Mats [SE/SE]; Önnemovägen 116, S-146 53 Tullinge (SE).

(74) Agents: BERGENTALL, Annika et al.; Cegumark AB, P.O. Box 53047, S-400 14 Göteborg (SE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: ACTIVE IMPEDANCE CONVERTER



(57) Abstract

The invention relates to an active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance. The impedance converter is provided with an amplifier (15, 16, 17, 19; 15a, 15b, 16a, 16b, 17a, 17b, 19) which input is connected to said first side of the circuit. The amplifier is adapted to provide low gain for low frequency signals and to change over to provide more gain for high frequency signals. The invention also relates to a splitter for splitting a subscriber line into a first transmission branch including a low pass filter and a second transmission branch including a high pass filter. The invention also comprises a termination of a twisted pair telephone transmission line for delivering two-way service including low frequency band telephone signals and high frequency band digital subscriber line signals.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

Title:

ACTIVE IMPEDANCE CONVERTER

TECHNICAL FIELD

The present invention relates to an active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance. The present invention also relates to a splitter for splitting a subscriber line into a first transmission branch including a low pass filter for providing telephone service signal transmissions along said subscriber line and a second transmission branch including a high pass filter for attenuating said telephone service signals and for providing high rate digital data transmissions along said subscriber line. The invention also relates to a termination of a twisted pair telephone transmission line for delivering two-way service including low frequency band telephone signals and high frequency band digital subscriber line signals.

STATE OF THE ART

In the field of conventional twisted pair telephone transmission lines for delivering two-way service, there is a growing world-wide interest in providing high rate digital transmission over the copper access network (POTS). This is due in part to the desire to take advantage of the large installation base that already exists, without the need to wait for the deployment of fibre lines in the access network. Examples of such systems include Asymmetric Digital Subscriber Line (ADSL) and a very high speed version (VADSL).

A vital part of this technology lies in its ability to simultaneously support secure telephony while delivering the broadband service. This facility obviates any need for extra copper pairs which would otherwise destroy the big advantage over fibre installation. To enable this, the telephony signals are separated from the ADSL signals by means of a pair of splitters, one in the central office and one at the customer's premises. Thus, the splitters provides the filtering required to separate the POTS and the ADSL bands before being input to their respective transceivers. Normally there is a low pass filter between the telephone and the line, and a high pass filter between the ADSL transceiver and the line. The insulation generated by the splitter is important for power limiting and for the removal of transients.

In many countries, POTS uses complex, i.e. capacitive impedances for termination and balance in the transmission bridges at telephone and central office. The introduction of the ADSL technique into POTS will not be successful if it involves a reduced quality in the transmission of speech or if the digital signals are influenced by transients in the POTS. For example, the speech quality may be impaired by echo, sidetone or transmission loss. On the other hand, the digital signals may be influenced by the low frequency POTS signalling voltages.

A passive inductance-capacitance filter within each respective passband has an almost entirely resistive impedance. This necessitates some form of impedance conversion, to meet demands from the operator that operational damping and reflection damping should be measured against a complex impedance. The impedance for POTS signalling frequencies must be high for an unterminated filter. Usually, the impedance converter function of the impedance

converters is 1 for this frequency, and therefore the impedance of the low pass filter must be high.

A splitter having an active impedance converter is described in "ADSL and VADSL Splitter Design and Telephony Performance", by John Cook and Phil Sheppard, IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 13, NO. 9, DECEMBER 1995. This impedance converter is provided with an amplifier which has more gain for low frequencies than for high frequencies. As a consequence of this, a high inductance transformer is needed which causes problems with a high leakage inductance for high frequencies. A separate filter is needed for frequencies below 300 Hz in order to quench the 25 Hz POTS ringing signals, or the 50 or 60 Hz electric power supply transients. The impedance for the filters will be too low so that the parallel capacitances will load ringing signals and impulsing for POTS excessively.

SUMMARY OF THE INVENTION

One object of the invention is therefore to provide a simple and efficient active impedance converter which reduces the above described problems.

According to the invention, this is accomplished by means of an active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance, which circuit is characterized in an amplifier which is connected to said first side of the circuit, and which amplifier is adapted to provide low gain for low frequency signals and to change over to provide more gain for high frequency signals.

In a particular embodiment of the invention, the amplifier comprises a capacitor, a first resistor, an operational amplifier and a second resistor.

According to another embodiment of the invention, the capacitor is connected in series with the first resistor and said first resistor is connected in series with the operational amplifier which is connected in parallel with the second resistor.

Preferably, first the capacitor acts as a block for direct current, and secondly it is dimensioned to function as a provider of reactance.

According to still another embodiment of the invention, the amplifier is connected to a subscriber line via a transmission line bridge comprising three co-operating transformer inductor coils which are connected to said subscriber line for providing a balancing impedance. This version of the invention is a simple and efficient means for providing balance damping as well as damping of longitudinal interferences.

Preferably, the amplifier is complemented by an additional amplifier. This version of the invention provides efficient means for driving the transformer inductor coils.

A preferred embodiment of the invention is used for separating ADSL signals from mixed ADSL and POTS signal transmissions along a twisted pair telephone transmission line.

The splitter according to the invention comprises an active impedance converter circuit with a first side with complex

impedance and a second side with complex/resistive impedance, and is characterized in that the impedance converter circuit comprises an amplifier which is connected to said first side of the circuit, and which amplifier is adapted to provide a low gain for low frequency signals and to change over to provide more gain for high frequency signals.

The termination in accordance with the invention comprises a splitter for splitting a subscriber line into a first transmission branch including a low pass filter for providing telephone service signal transmissions along said subscriber line and a second transmission branch including a high pass filter for attenuating said telephone service signals and for providing high rate digital data transmissions along said subscriber line, said splitter comprising an active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance. This termination is characterized in that the impedance converter circuit comprises an amplifier which is connected to said first side of the circuit, and which amplifier is adapted to provide a low gain for low frequency signals and to change over to providing more gain by means of high frequency signals.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will in the following be further described in a non-limiting way with reference to the accompanying drawings in which:

Fig. 1 is a circuit diagram showing the active impedance converter circuit according to a first embodiment of the invention,

Fig. 2 shows a graph of the input signal/frequency, associated with the impedance converter of Fig. 1,

Fig. 3 is a circuit diagram showing the active impedance

converter circuit according to the second embodiment of the invention,

Fig. 4 is a circuit diagram showing the active impedance converter according to the third embodiment of the invention, and

Fig. 5 schematically illustrates a realized version of the impedance converter circuit of Fig. 4.

DESCRIPTION OF PREFERRED EMBODIMENTS

The active impedance converter circuit according to the present invention is included in the termination of a telephone subscriber line which presents both complex and resistive impedance.

The circuit may for example be used in an ADSL splitter where the line is specified as complex for low frequencies like POTS (0.3 - 3.4 kHz) and complex or resistive for ADSL frequencies (30 - 1100 kHz) as well as the associated high pass and low pass filters. The circuit is designed for so called twisted pair telephone transmission lines for delivering two-way service.

The circuit diagram in Fig. 1 shows a theoretical model of a first unbalanced version of the impedance converter. At the left side of the diagram, the telephone or the line is represented by an AC generator 10 where one of the generator outputs is connected to ground via two resistors 11 and 12 and a capacitor 13 in parallel with said resistor 12 which represents the specified complex impedance. The other generator output is connected via a first branch of the circuit to one end of a first transformer inductor coil 14.

A second branch of the circuit is connected to an amplifier comprising a capacitor 15 which is connected in series with a resistor 16 to the inverting input of an operational amplifier 17. This side of the circuit with said two branches constitutes the complex net side of the circuit.

The other end of the coil 14 is connected to ground via a resistor 18. This side of the circuit represents the resistive net side of the circuit, e.g. the high pass and the low pass filters.

The amplifier also comprises a resistor 19 which is connected in parallel with the operational amplifier 17, the output of which is connected via a resistor 20 to one end of a second transformer inductor coil 21. The other end of the coil 21 is connected directly to ground. The two transformer inductor coils 14 and 21 co-operate to form a 1:1 transformer.

The amplifier 15, 16, 17 and 19 provides a gain f = $\dfrac{R_1 \cdot N}{R_2 + \dfrac{1}{j\omega C_7}}$

where R_1 is the resistor 19, N is the transformer ratio 1:1, R_2 is the resistor 16 and C_7 is the capacitor 15.

$$Z_{IN} = R_{11} + \frac{R_{12}}{1 + j\omega R_{12} \times C_{13}}$$

Accordingly, the impedance $Z_{OUT+} = Z_{IN}\left(1 + \dfrac{R_1 \cdot N}{R_2 + \dfrac{1}{j\omega C_7}}\right)$

Z_{IN} has an equivalent impedance network built with one capacitor C_S in serial with a resistor R_S and both in parallel with a resistor R_P. This network with a serial network C_S has the same relationship between the component values, if N=1, as the invention feedback network R_1, R_2, and C_7.

Fig. 2 illustrates the amplitude of the IN-signal (V_{IN+}) which is about 1 Volt from 0.3 kHz to 1100 kHz. Thus, the IN-impedance is equal to the impedance of the generator 11-13. Because the load 18 is resistive the gain increases by frequency and the circuit characteristics is dimensioned so that the above described impedance converter acts as a controller by manipulating the voltage over the transformer 14, 21, so that the electric current in the loop becomes similar to the electric current for a complex termination in accordance with the generator impedance.

Fig. 3 illustrates a theoretical model of a second, balanced version of the impedance converter. The same reference numbers have been used for similar components, as in the impedance converter in accordance with Fig. 1. At the left side of the diagram, the telephone or the line is again represented by the AC generator 10. The most significant difference lies in that a balancing impedance has been provided for the IN- signal by means of a third co-operating inductor coil 22 and the amplifier.

The IN+ voltage of the generator output is, as in Fig. 1, connected via the first branch of the circuit to the end of the first transformer inductor coil 14. The second branch of the circuit is connected to an amplifier comprising the capacitor 15a which is connected in series with the resistor 16a to the

inverting input of the operational amplifier 17a. The other end of the coil 14 is connected to OUT+ via the load resistor 18b.

The amplifier also comprises the resistor 19a which is connected in parallel with the operational amplifier 17a, the output of which is connected via the resistor 20 to one end of a second transformer inductor coil 21. The other end of the coil 21 is connected to ground. The three transformer inductor coils 14, 21 and 22 co-operate to form a 2:1:1 transformer.

The IN- impedance 11-13 of the generator output is connected to one end of the balancing inductor coil 22. The other end of the coil 22 is connected to OUT- and the load resistor 18a. The IN- impedance of the generator 10 is also connected to the amplifier via a capacitor 15b and a resistor 16b to the non-inverting input of the operational amplifier 17. A resistor 19b is connected in parallel with the operational amplifier 17.

Fig. 4 illustrates a theoretical model of a third, balanced version of the impedance converter. The same reference numbers have been used for similar components, as in the impedance converter in accordance with Fig. 1 and 3. At the left side of the diagram, the telephone or the line is again represented by the AC generator 10. The most significant difference with reference to the previously described embodiment according to Fig. 3, lies in the addition of a second operational amplifier 17b.

The IN+ voltage of the generator output is, as in Fig. 3, connected via the first branch of the circuit to the end of the first transformer inductor coil 14. The second branch of the circuit is connected to the first amplifier comprising the

capacitor 15a which is connected in series with the resistor 16a to the inverting input of the first operational amplifier 17a. The other end of the coil 14 is connected to OUT+ via the load resistor 18b.

The amplifier also comprises the resistor 19a which is connected in parallel with the operational amplifier 17a, the output of which is connected via the resistor 20 to one end of a second transformer inductor coil 21. The other end of the coil 21 is connected to the output of the second operational amplifier 17b. The three transformer inductor coils 14, 21 and 22 co-operate to form a 2:1:1 transformer.

The IN- impedance 11-13 of the generator output is connected to one end of the balancing inductor coil 22. The other end of the coil 22 is connected to OUT- and the load resistor 18a. The IN- impedance of the generator 10 is also connected to the second amplifier comprising the capacitor 15b which is connected in series with the resistor 16b to the inverting input of the second operational amplifier 17b. A resistor 19b is connected in parallel with the second operational amplifier 17b.

Fig. 5 illustrates the realized version of the impedance converter circuit of Fig. 4. The three transformer inductor coils 14, 21 and 22 co-operate to form a 1:1:1 transformer.

The invention is not limited to the above described embodiments, instead several modifications may be made within the scope of the invention.

CLAIMS

1. An active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance,
c h a r a c t e r i z e d in an amplifier (15, 16, 17, 19; 15a, 15b, 16a, 16b, 17a, 17b, 19) which is connected to said first side of the circuit, and which amplifier is adapted to provide low gain for low frequency signals and to change over to provide more gain for high frequency signals.

2. A circuit according to claim 1,
c h a r a c t e r i z e d in that the amplifier comprises a capacitor (15; 15a, 15b), a first resistor (16; 16a, 16b), an operational amplifier (17; 17a, 17b) and a second resistor (19; 19a, 19b).

3. A circuit according to claim 2,
c h a r a c t e r i z e d in that the capacitor (15; 15a, 15b) is connected in series with the first resistor (16; 16a, 16b), and that said first resistor is connected in series with the operational amplifier (17; 17a, 17b) which is connected in parallel with the second resistor (19; 19a, 19b).

4. A circuit according to claim 2 or 3,
c h a r a c t e r i z e d in that the capacitor (15; 15a, 15b) first acts as a block for direct current, and secondly it is dimensioned to function as a provider of reactance.

5. A circuit according to any one of claims 1 to 4,

characterized in that the amplifier is connected to a subscriber line via a transmission line bridge comprising three co-operating transformer inductor coils (14, 21, 22) for providing balancing impedance to said subscriber line.

6. A circuit according to any one of claims 1 to 5, characterized in that the amplifier (15a, 16a, 17a, 19a) is complemented by an additional amplifier (15b, 16b, 17b, 19b).

7. Use of a circuit according to any of the above claims for separating ADSL signals from mixed ADSL and POTS signal transmissions along a twisted pair telephone transmission line.

8. A splitter for splitting a subscriber line into a first transmission branch including a low pass filter (18; 18a, 18b) for providing telephone service signal transmissions along said subscriber line and a second transmission branch including a high pass filter (18; 18a, 18b) for attenuating said telephone service signals and for providing high rate digital data transmissions along said subscriber line, said splitter comprising an active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance, characterized in an amplifier (15, 16, 17, 19; 15a, 15b, 16a, 16b, 17a, 17b, 19) which is connected to said first side of the circuit, and which amplifier is adapted to provide low gain for low frequency signals and to change over to provide more gain for high frequency signals.

9. A splitter according to claim 8,

c h a r a c t e r i z e d in that the amplifier comprises a capacitor (15; 15a, 15b), a first resistor (16; 16a, 16b), an operational amplifier (17; 17a, 17b) and a second resistor (19; 19a, 19b).

10. A splitter according to claim 9,
c h a r a c t e r i z e d in that the capacitor (15; 15a, 15b) is connected in series with the first resistor (16; 16a, 16b), and that said first resistor is connected in series with the operational amplifier (17; 17a, 17b) which is connected in parallel with the second resistor (19; 19a, 19b).

11. A splitter according to claim 9 or 10,
c h a r a c t e r i z e d in that the capacitor (15; 15a, 15b) first acts as a block for direct current, and secondly it is dimensioned to function as a provider of reactance.

12. A splitter according to any one of claims 8 to 11,
c h a r a c t e r i z e d in that the amplifier is connected to a subscriber line via a transmission line bridge comprising three co-operating transformer inductor coils (14, 21, 22) for providing balancing impedance to said subscriber line.

13. A splitter according to any one of claims 8 to 12,
c h a r a c t e r i z e d in that the amplifier (15a, 16a, 17a, 19a) is complemented by an additional amplifier (15b, 16b, 17b, 19b).

14. Use of a splitter according to any one of claims 8 to 12, for separating ADSL signals from mixed ADSL and POTS signal transmissions along a twisted pair telephone transmission line.

15. A termination of a twisted pair telephone transmission line for delivering two-way service including low frequency band telephone signals and high frequency band digital subscriber line signals, said termination comprising a splitter for splitting a subscriber line into a first transmission branch including a low pass filter (18; 18a, 18b) for providing telephone service signal transmissions along said subscriber line and a second transmission branch including a high pass filter (18; 18a, 18b) for attenuating said telephone service signals and for providing high rate digital data transmissions along said subscriber line, said splitter comprising an active impedance converter circuit with a first side with complex impedance and a second side with complex/resistive impedance,
c h a r a c t e r i z e d in an amplifier (15, 16, 17, 19; 15a, 15b, 16a, 16b, 17a, 17b, 19) which is connected to said first side of the circuit, and which amplifier is adapted to provide low gain for low frequency signals and to change over to provide more gain for high frequency signals.

16. A termination according to claim 15,
c h a r a c t e r i z e d in that the amplifier comprises a capacitor (15; 15a, 15b), a first resistor (16; 16a, 16b), an operational amplifier (17; 17a, 17b) and second resistor (19; 19a, 19b).

17. A termination according to claim 16,
c h a r a c t e r i z e d in that the capacitor (15; 15a, 15b) is connected in series with the first resistor (16; 16a, 16b), and that said first resistor is connected in series with the

operational amplifier (17; 17a, 17b) which is connected in parallel with the second resistor (19; 19a, 19b).

18. A termination according to claim 16 or 17, c h a r a c t e r i z e d in that the capacitor (15; 15a, 15b) first acts as a block for direct current, and secondly it is dimensioned to function as a provider of reactance.

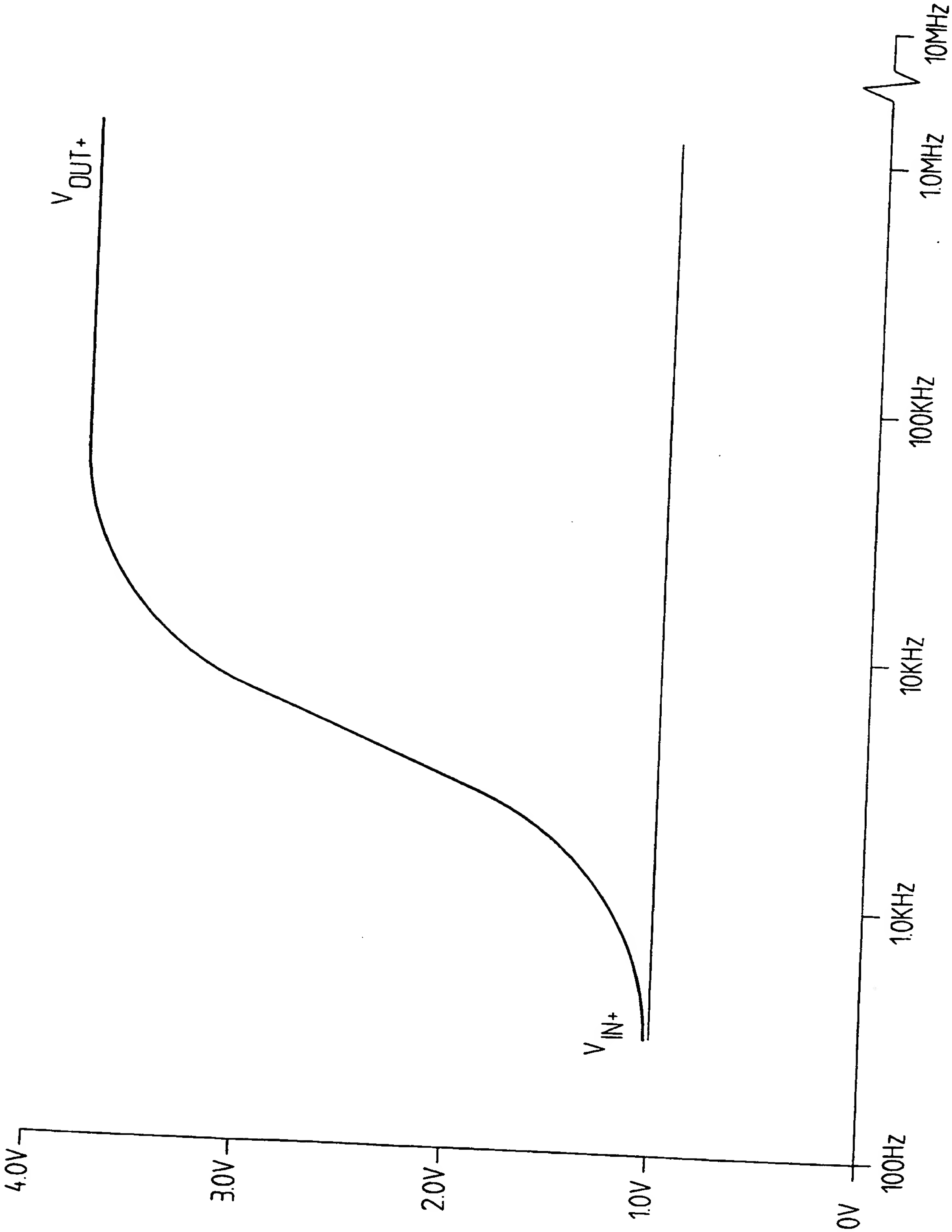
19. A termination according to any one of claims 15 to 18, c h a r a c t e r i z e d in that the amplifier is connected to a subscriber line via a transmission line bridge comprising three co-operating transformer inductor coils (14, 21, 22) for providing balancing impedance to said subscriber line.

20. A termination according to any one of claims 15 to 19, c h a r a c t e r i z e d in that the amplifier (15a, 16a, 17a, 19a) is complemented by an additional amplifier (15b, 16b, 17b, 19b).

21. Use of a termination according to any one of claims 11 to 14, for separating ADSL signals from mixed ADSL and POTS signal transmissions along a twisted pair telephone transmission line.

BNSDOCID: <WO___9939433A1_I_>

Fig. 2


4.0V
3.0V
2.0V
1.0V
0V
100Hz
1.0KHz
10KHz
100KHz
1.0MHz
10MHz
V_{OUT+}
V_{IN+}

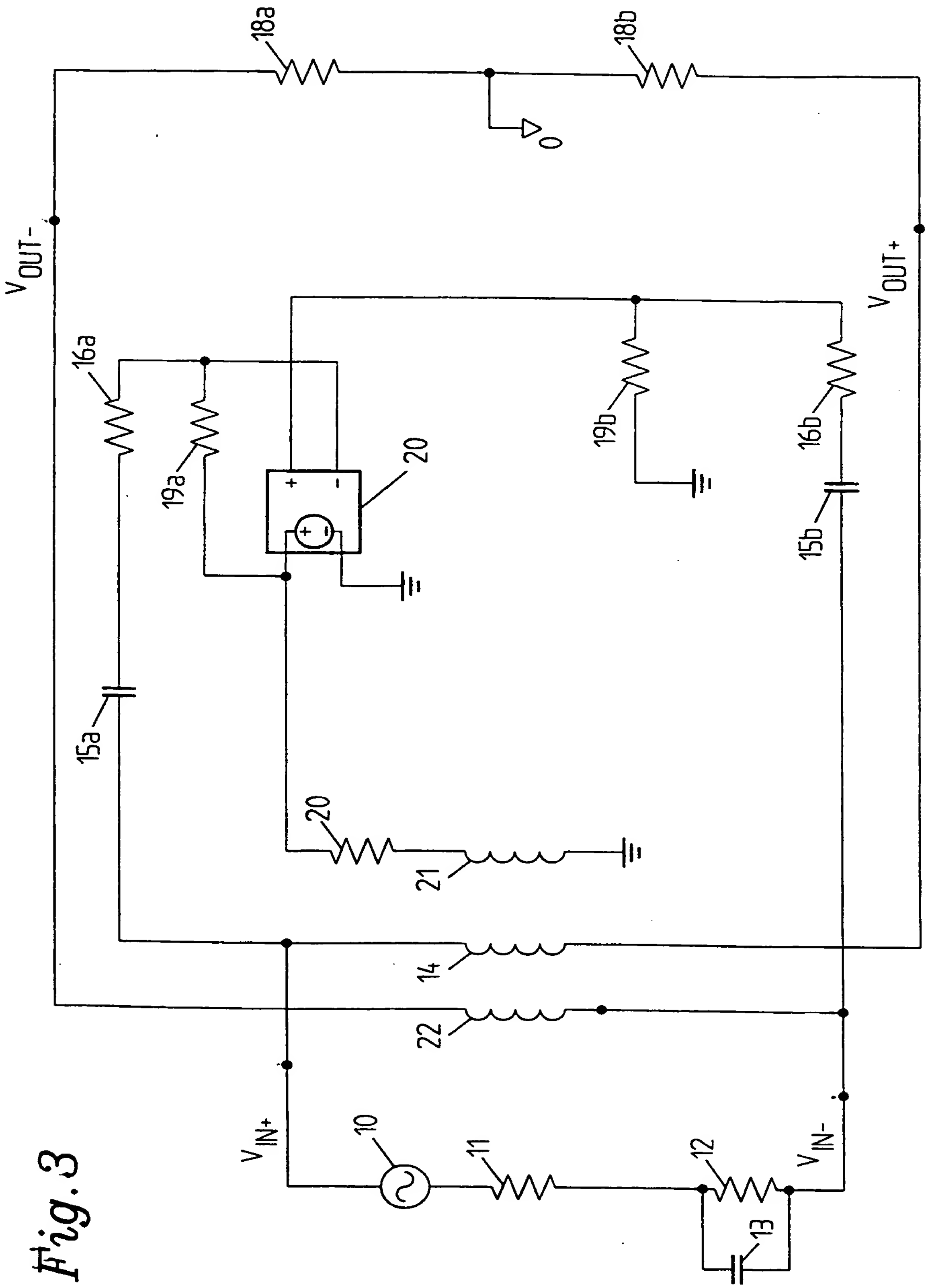

18a
18b
o
VOUT-
VOUT+
16a
19a
20
+
-
19b
16b
15b
15a
20
21
14
22
VIN+
VIN-
10
11
12
13

Fig.3

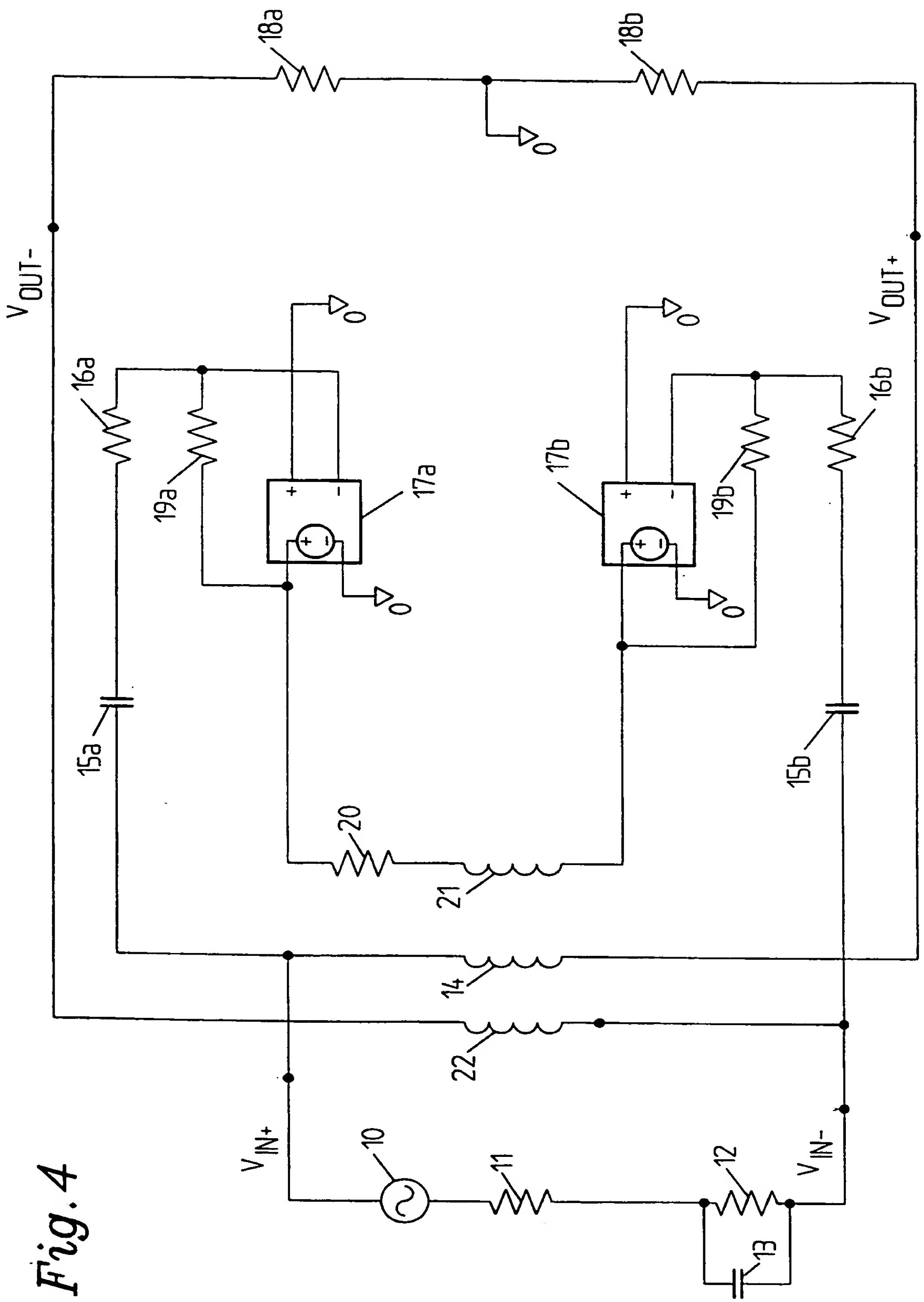

18a
18b
0
V OUT-
V OUT+
16a
19a
17a
17b
19b
16b
15a
15b
20
21
14
22
V IN+
V IN-
10
11
12
13

Fig. 4

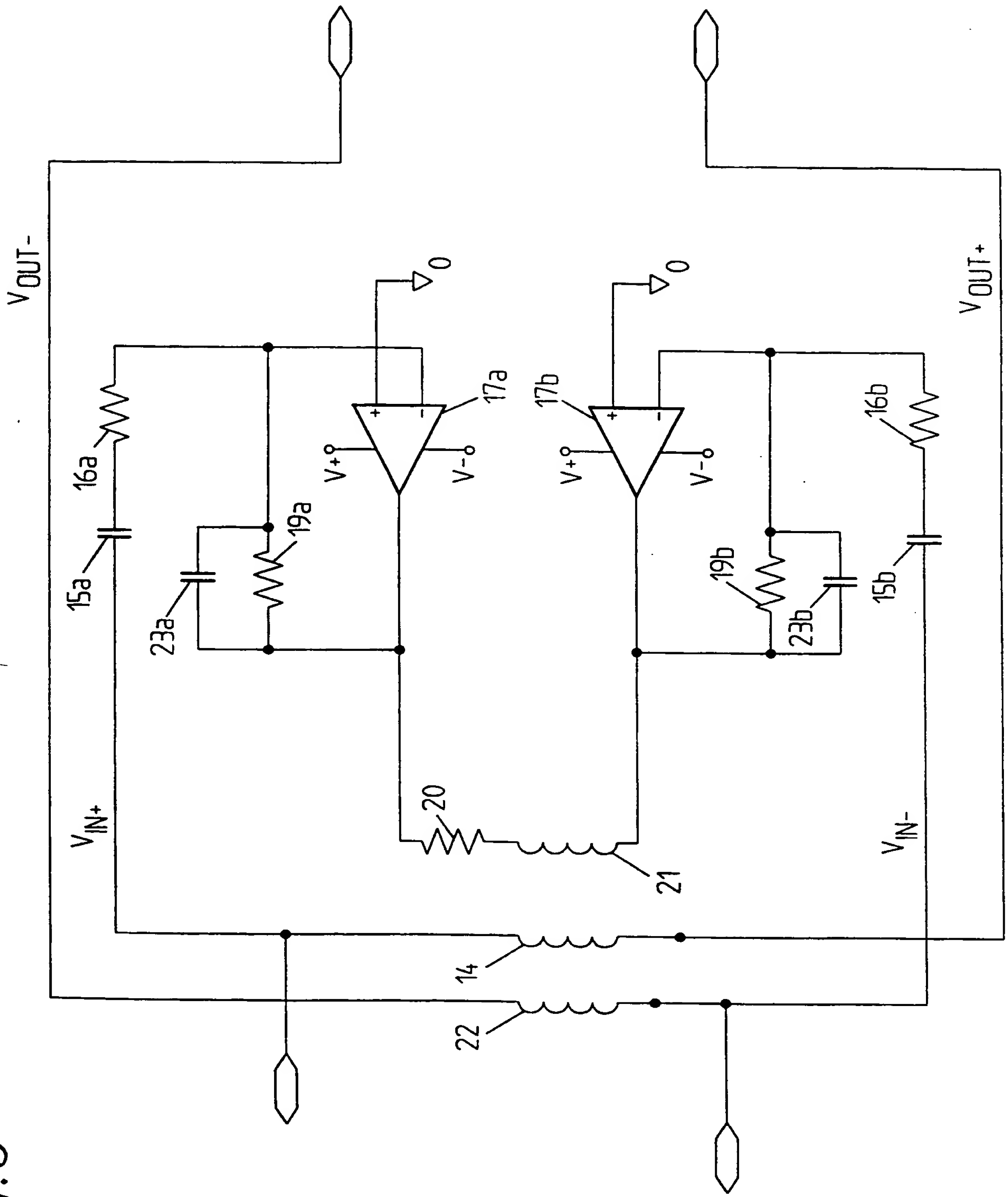

V_OUT-
V_OUT+
V_IN+
V_IN-
0
0
V+
V-
V+
V-
17a
17b
16a
15a
23a
19a
19b
23b
15b
16b
20
21
14
22

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00036

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H03H 11/04, H04M 11/06, H04L 5/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H03H, H04M, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, INSPEC, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0678979 A2 (AT&T CORP.), 25 October 1995 (25.10.95), see whole document --	1-21
A	WO 9720396 A2 (ANALOG DEVICES, INC.), 5 June 1997 (05.06.97), see whole document --	1-21
A	US 5623543 A (JOHN W. COOK), 22 April 1997 (22.04.97), see whole document -- --------	1-21

☐ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 June 1999	30 -06- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Bo Gustavsson/MN Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/06/99

International application No.
PCT/SE 99/00036

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0678979 A2	25/10/95	JP 7303020 A	14/11/95
		US 5528630 A	18/06/96
WO 9720396 A2	05/06/97	AU 1079797 A	19/06/97
		EP 0864219 A	16/09/98
		US 5757803 A	26/05/98
US 5623543 A	22/04/97	AU 694477 B	23/07/98
		AU 1542195 A	21/08/95
		CA 2182383 A	10/08/95
		CN 1139996 A	08/01/97
		DE 69505103 D,T	15/04/99
		EP 0742972 A,B	20/11/96
		SE 0742972 T3	
		ES 2123956 T	16/01/99
		JP 9509798 T	30/09/97
		NZ 278932 A	24/06/97
		WO 9521488 A	10/08/95